American Society of Civil Engineers

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On behalf of the

Structural Engineering Institute
of the
American Society of Civil Engineers

Before the

Committee on Science
U.S. House of Representatives

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Mr. Chairman and Members of the Committee:

Good morning. My name is James Harris, and I am pleased to appear on behalf of the Structural Engineering Institute of American Society of Civil Engineers (ASCE/SEI)[1] as you examine "**The Investigation of the World Trade Center Collapse: Finding, Recommendation and Next Steps**" in light of the release of findings and recommendations of the National Institute of Standards and Technology investigation.

The events at the World Trade Center in New York City on September 11, 2001, were the worst building disasters in the history of the United States. The National Institute of Standards and Technology conducted a building and fire safety investigation of the disaster under the authority of the National Construction Safety Team Act (15 USC 7301 et seq). As a result of its WTC Investigation, on June 23, 2005 NIST issued a draft report with recommendations, and invited public comments on June 23, 2005.

ASCE/SEI supports a thorough review and deliberation of all of the NIST Recommendations and looks forward to further discussions clarifying the situations to which the NIST Recommendations should apply.

ASCE/SEI believes that engineers must avoid over-optimistic reassurances about building safety, and agrees that increased efforts should be focused on preventing terrorist attacks. That said, the 30 recommendations presented by NIST within eight categories address a range of issues that we at ASCE/SEI think require serious discussion. Many of the recommendations were presented by NIST as "changes to codes and standards," which some may interpret to mean that the painstaking process of developing consensus code and standard provisions should be unreasonably accelerated. We believe that the consensus process, which is already underway at ASCE/SEI for some of the concerns NIST has raised, is essential so that all aspects of an issue can be considered. All of the issues deserve further consideration in that community.

In the view of ASCE/SEI, at least some of the NIST recommendations will require development of new technologies and close examination of their effects upon the practice. At the same time, the existing codes and standards processes that are already

1 ASCE, founded in 1852, is the country's oldest national civil engineering organization. It represents more than 139,000 civil engineers in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE carried out Building Performance Assessments of the World Trade Center, the Pentagon and the Murrah Federal Building, and its technical assessments following earthquakes, hurricanes, and other natural disasters. The New Orleans levee technical group includes representatives appointed by the ASCE Geo-Institute and ASCE Coasts, Oceans, Ports, and Rivers Institute. ASCE is a 501(c) (3) non-profit educational and professional society.

in place, both in and outside ASCE/SEI, provide appropriate mechanisms for advancing several of these discussions. Ultimately, the implementation of these recommendations will require the development of appropriate thresholds and bounds for their application. ASCE/SEI looks forward to taking an integral role in clarifying the application of these recommendations.

In fact, some of the NIST recommendations follow actions previously initiated by ASCE/SEI. For example, with respect to Recommendation #2, ASCE/SEI is close to issuing a Wind Tunnel Testing standard and anticipates opening it for public comment. With respect to Recommendation #9, ASCE/SEI has been working with the Society of Fire Protection Engineers, and has already prepared a draft to update ASCE/SEI/SFPE 29-99 (Standard Calculation Methods for Structural Fire Protection), by incorporating performance-based fire resistant design. With regard to Recommendation #27, we look forward to engaging ASCE's professional practices committee for comment and guidance, though our initial reaction is that it may not be necessary or beneficial to all parties for the Engineer of Record to retain all documents for all time; our preliminary view on document retention is that the owner should retain the drawings.

ASCE/SEI favors the development of tools to assist engineers in addressing the issue of progressive collapse (Recommendation #1). The development of a consensus document providing multiple approaches to mitigating progressive collapse would benefit the profession by providing concepts and techniques upon which to build. It is worth noting that GSA requirements have already advanced technology for evaluating progressive collapse. In general, ASCE/SEI prefers a building-specific and/or owner-specific approach to mitigating progressive collapse rather than a code-mandated requirement.

However, also with respect to Recommendation #1, the ASCE/SEI reserves judgment on whether and how to develop standardized software to evaluate the susceptibility of a particular structural system to progressive collapse. Not all buildings are at risk of being exposed to the type of events commonly associated with initiating progressive collapse. This NIST recommendation needs study of its application and its effect upon the profession because of the various design thresholds involved. When considering possible causation events, other, non-structural, solutions are sometimes effective. Having said that, we look forward to discussing who would develop and maintain the potential software, who would distribute it and who would take responsibility for training the profession in its use.

ASCE/SEI agrees that designing for fire performance of structures (Recommendations #4-7) needs to be discussed within the broad engineering profession, and is interested in taking an active role in supporting studies examining these recommendations. A draft has been prepared and we would welcome NIST's input in furthering the development of this standard. The concept embedded in Recommendation #8 of treating fire as a load case for structural design will necessitate assumption concerning fire protection

systems. Their historical performance will need to be included in the discussions along with the technical and economic impact.

ASCE/SEI feels that some of the NIST recommendations need further clarification and discussion. ASCE/SEI would like a clearer description of the rationale and motivation for developing limit state criteria in Recommendation #3. It is possible that serviceability, perception of motion issues, and existing seismic criteria on drift may satisfy this recommendation. While much of Recommendation #25 appears to ASCE/SEI to be reasonable, the concept of certification of "as-designed or as-built" safety needs additional discussion and understanding. Without further understanding of the envisioned intent of this recommendation, its implementation may face numerous technical, economic, and authoritative hurdles. Improving safety in existing buildings, as directed in Recommendation #26, is certainly a laudable goal and one that ASCE/SEI supports. While the existence of as-built drawings would assist in the rehabilitation of existing structures as specified in Recommendation #26, a requirement for the retention of a broad range of documents would not improve the safety or performance of structures. Lastly, the roles of various professionals within a project will change and vary from project to project. The assignment of roles and responsibilities is an issue best handled by the contract documents rather than codes and standards, as proposed in Recommendation #28.

ASCE also supports Recommendations #29 and #30 which call for increased continuing professional development for engineers and the curriculum be expanded strengthen the base of available technical capabilities and human resources. It is essential that practicing civil engineers remain current with issues and advancements in technology. ASCE supports the attainment of a Body of Knowledge for entry into the practice of civil engineering at the professional level. The Body of Knowledge prescribes the necessary depth and breadth of knowledge, skills, and attitudes required of an individual entering the practice of civil engineering at the professional level in the 21st Century. Establishing innovative solutions to protect public health and safety requires coordination, training and sustained research and development.

We are particularly encouraged by the recommendations pertaining to education and we enthusiastically support continuing education of the profession. However, specific issues, such as cross-training of fire and structural engineering professionals, need to be clarified in further discussions.

Our profession is responsible for protecting the public to the best of our abilities and to seek new technologies to help us meet that charge. In order to do that, we feel it is important to draw a distinction between advancing the technology through the development of various tools, such as consensus documents on progressive collapse and fire-structure interaction, and potentially adversely affecting the profession by imposing regulations and restricting the engineers' freedom to develop the best solution

for each individual building and the embedding of mandatory provisions in building codes.

While not every NIST recommendation may be ready for enactment as is, ASCE/SEI is moving forward with discussion of the issues and their implications for structural engineering practice, and looks forward to working closely with NIST to clarify the application of these recommendations.

NIST Recommendations Referenced:

Recommendation 1. NIST recommends that: (1) progressive collapse should be prevented in buildings through the development and nationwide adoption of consensus standards and code provisions, along with the tools and guidelines needed for their use in practice; and (2) a standard methodology should be developed—supported by analytical design tools and practical design guidance—to reliably predict the potential for complex failures in structural systems subjected to multiple hazards.

Recommendation 2. NIST recommends that nationally accepted performance standards be developed for: (1) conducting wind tunnel testing of prototype structures based on sound technical methods that result in repeatable and reproducible results among testing laboratories; and (2) estimating wind loads and their effects on tall buildings for use in design, based on wind tunnel testing data and directional wind speed data.

Recommendation 3. NIST recommends that an appropriate criterion should be developed and implemented to enhance the performance of tall buildings by limiting how much they sway under lateral load design conditions (e.g., winds and earthquakes).

Recommendation 4. NIST recommends evaluating, and where needed improving, the technical basis for determining appropriate construction classification and fire rating requirements (especially for tall buildings greater than 20 stories in height)—and making related code changes now as much as possible—by explicitly considering factors including:

- timely access by emergency responders and full evacuation of occupants, or the time required for burnout without local collapse;
- the extent to which redundancy in active fire protection (sprinkler and standpipe, fire alarm, and smoke management) systems should be credited for occupant life safety;
- the need for redundancy in fire protection systems that are critical to structural integrity;
- the ability of the structure and local floor systems to withstand a maximum credible fire scenario without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent;
- compartmentation requirements (e.g., 12,000 ft2 (24)) to protect the structure, including fire rated doors and automatic enclosures, and limiting air supply (e.g., thermally resistant window assemblies) to retard fire spread in buildings with large, open floor plans;
- the impact of spaces containing unusually large fuel concentrations for the expected occupancy of the building; and
- the extent to which fire control systems, including suppression by automatic or manual means, should be credited as part of the prevention of fire spread.

Recommendation 5. NIST recommends that the technical basis for the century-old standard for fire resistance testing of components, assemblies, and systems should be improved through a national effort. Necessary guidance also should be developed for extrapolating the results of tested assemblies to prototypical building systems.

Recommendation 6. NIST recommends the development of criteria, test methods, and

standards: (1) for the in-service performance of spray-applied fire resistive materials (SFRM, also commonly referred to as fireproofing or insulation) used to protect structural components; and (2) to ensure that these materials, as-installed, conform to conditions in tests used to establish the fire resistance rating of components, assemblies, and systems.

Recommendation 7. NIST recommends the nationwide adoption and use of the "structural frame" approach to fire resistance ratings.

Recommendation 8. NIST recommends that the fire resistance of structures should be enhanced by requiring a performance objective that uncontrolled building fires result in burnout without local or global collapse.

Recommendation 9. NIST recommends the development of: (1) performance-based standards and code provisions, as an alternative to current prescriptive design methods, to enable the design and retrofit of structures to resist real building fire conditions, including their ability to achieve the performance objective of burnout without structural or local floor collapse: and (2) the tools, guidelines, and test methods necessary to evaluate the fire performance of the structure as a whole system.

Recommendation 25. Nongovernmental and quasi-governmental entities that own or lease buildings and are not subject to building and fire safety code requirements of any governmental jurisdiction are nevertheless concerned about the safety of the building occupants and the responding emergency personnel. NIST recommends that such entities should be encouraged to provide a level of safety that equals or exceeds the level of safety that would be provided by strict compliance with the code requirements of an appropriate governmental jurisdiction. To gain broad public confidence in the safety of such buildings, NIST further recommends that it is important that as-designed and as-built safety be certified by a qualified third party, independent of the building owner(s). The process should not use self-approval for code enforcement in areas including interpretation of code provisions, design approval, product acceptance, certification of the final construction, and post-occupancy inspections over the life of the buildings.

Recommendation 26. NIST recommends that state and local jurisdictions should adopt and aggressively enforce available provisions in building codes to ensure that egress and sprinkler requirements are met by existing buildings44. Further, occupancy requirements should be modified where needed (such as when there are assembly use spaces within an office building) to meet the requirements in model building codes.

Recommendation 27. NIST recommends that building codes should incorporate a provision that requires building owners to retain documents, including supporting calculations and test data, related to building design, construction, maintenance and modifications over the entire life of the building45. Means should be developed for offsite storage and maintenance of the documents. In addition, NIST recommends that relevant building information should be made available in suitably designed hard copy or electronic format for use by emergency responders. Such information should be easily accessible by responders during emergencies.

Recommendation 28. NIST recommend that the role of the "Design Professional in Responsible Charge" should be clarified to ensure that: (1) all appropriate design professionals (including, e.g., the fire protection engineer) are part of the design team providing the standard of care when designing buildings employing innovative or unusual fire safety systems47, and (2) all appropriate design professionals (including, e.g., the structural engineer and the fire protection engineer) are part of the design team providing the standard of care when designing the structure to resist fires, in buildings that employ innovative or unusual structural and fire safety systems.

Recommendation 29. NIST recommends that continuing education curricula should be developed and programs should be implemented for training fire protection engineers and architects in structural engineering principles and design, and training structural engineers, architects, and fire protection engineers in modern fire protection principles and technologies, including fire-resistance design of structures.

Recommendation 30. NIST recommends that academic, professional short-course, and webbased training materials in the use of computational fire dynamics and thermostructural analysis tools should be developed and delivered to strengthen the base of available technical capabilities and human resources.